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AN EXPLORATION OF THE RELATIONSHIP BETWEEN DENSITIES OF TROUT AND WATER FERTILITY

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INTRODUCTION

As water fertility affects the potential productivity of streams, it was questioned whether a relationship between total alkalinity and trout densities exists. Wisconsin has been separated into valid hydrochemical lake regions with respect to alkalinity using soil, glacial and bedrock provinces (Poff, 1970). There were three valid bedrock provinces found, basically dividing the state into northern, central and southern sections (Figure 1).

Total alkalinity, which measures the available amounts of carbonates, bicarbonates and hydroxides in water, expressed as mg/l of $CaCO_3$, is a common measurement of water fertility. In general, the greater the total alkalinity (fertility), the greater the potential productivity of the water. Moyle (1946) found a correlation between fish production and alkalinity. Test netting on Minnesota lakes showed a lower average catch from waters with a total alkalinity below 40 ppm than from harder waters.

Trout population data was extracted from surveys on streams in each valid bedrock province to try to determine the basic trout population structures of streams in each province. While other parameters besides alkalinity vary between these three provinces (water temperatures, base flows, bottom substrate, etc.), they provide convenient dividing lines between basic stream types.

METHODS

Fish population data was taken from stream surveys conducted by Department of Natural Resources personnel over the last 19 years. Only surveys of "average" trout streams were used; marginal trout streams, or those with obvious problems, such as heavy pollution or ditching, were not included. In most surveys at least 1.0 acre of stream was shocked, and in all cases only one run was made. Survey data was collected at various times of the year; however, it was felt any variables introduced by this factor would be negated due to the number of samples.

A total of 62 streams were smpled in province 1, 91 in province 2, and 42 in province 3.

There are inherent biases involved with electrofishing sampling. High water, stream size, turbidity, electrical conductivity of the water, and water velocity all influence the number of fish taken from a population (Beyerle and Cooper, 1960). Size of fish is also a factor as electrofishing is more effective on larger specimens. On the Popple River, a soft water northeast Wisconsin stream, a first run electrofishing efficiency of 50% or greater on yearling and older trout was established (Mason and Wegner, 1970).

Due to these factors, the following population estimates are undoubtedly low, but they do provide an index of relative abundance of trout in streams of each bedrock province.

In most surveys the fish population was expressed as trout per acre rather than the more meaningful indication of pounds per acre.

RESULTS

Province 1 averaged the highest estimated trout per acre with 161. Province 2 was next with 124, and province 3 had 88 trout per acre (Table 1).

In province 1, brook trout made up 71% of the average estimated population, with brown trout making up 23% and rainbow trout 6%. In province 2, brook trout made up 60% of the average estimated population, with brown trout making up 35% and rainbow trout 5%. In province 3, brook trout made up 36% of the average estimated population, with brown trout making up 58% and rainbow trout 6%. These figures are presented graphically in Figure 2.

In province 1, brook trout were found in 97% of the sampled streams and averaged 119 per acre. Brown trout were found in 63% of the sampled streams and averaged 58 per acre. Rainbow trout were found in 11% of the sampled streams and averaged 67 per acre.

In province 2, brook trout were present in 86% of the sampled streams and averaged 85 per acre. Brown trout were found in 74% of the sampled streams and averaged 60 per acre. Rainbow trout were found in 16% of the sampled streams and averaged 33 per acre.

In province 3, brook trout were present in 41% of the sampled streams and averaged 79 per acre. Brown trout were found in 86% of the sampled streams and averaged 59 per acre. Rainbow trout were found in 36% of the sampled streams and averaged 15 per acre. This data is summarized in Figure 3.

These figures can be compared to more detailed population studies. A study was made on McKenzie Creek, Polk County, a province 1 stream (Lowry, 1971). Population estimates were made in the fall from 1957 through 1964 using formula discussed by Ricker (1958). Using this data, an estimate of 240 trout per acre was made, compared to 161 trout per acre for all sampled streams in province 1.

A Peterson's formula estimate of 651 trout per acre was made in 1968 on Chaffee Creek, Marquette County, a province 2 stream. This compares with the average 124 trout per acre of all sampled streams in province 2.

A two-run population estimate was made on Mt. Vernon Creek, Dane County, a province 3 stream, in 1967. The estimate was 339 trout per acre as compared to 88 trout per acre for all sampled streams in province 3. While these figures indicate the one-run samples provided low estimates, it should be noted that the three above-mentioned streams are above average trout streams for their respective provinces.

DISCUSSION

Trout densities were not found to correlate with total alkalinity. Province 3 had the highest average alkalinity (267 ppm), yet lowest trout per acre (88). Province 1 had the lowest average alkalinity (90 ppm) and the highest trout per acre (161). If anything, there was an inverse correlation (Table 1).

This can be attributed to several factors. Poor trout habitat in some southern streams may have negated much of their trout producing potential. A major factor is species make up. A definite species shift from north to south was noted. The relatively small, prolific brook trout was the dominant trout in the north, while the larger brown trout was dominant in the south. This, coupled with the fact that trout undoubtedly grow faster in the south, may mean that trout biomass may actually be greater in southern Wisconsin streams even though trout densities are less. A study expressing trout biomass in pounds per acre might show that a relationship between alkalinity and trout productivity does exist.

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Table 1.

Province	No. Sampled Streams	No. Trout Streams	Average Alkalinity	Average Trout/Acre	Range	Standard Deviation
I	62	958	90	161	20-680	160.53
II	91	505	142	124	20-651	121.34
III	42	165	267	88	20-297	83.92

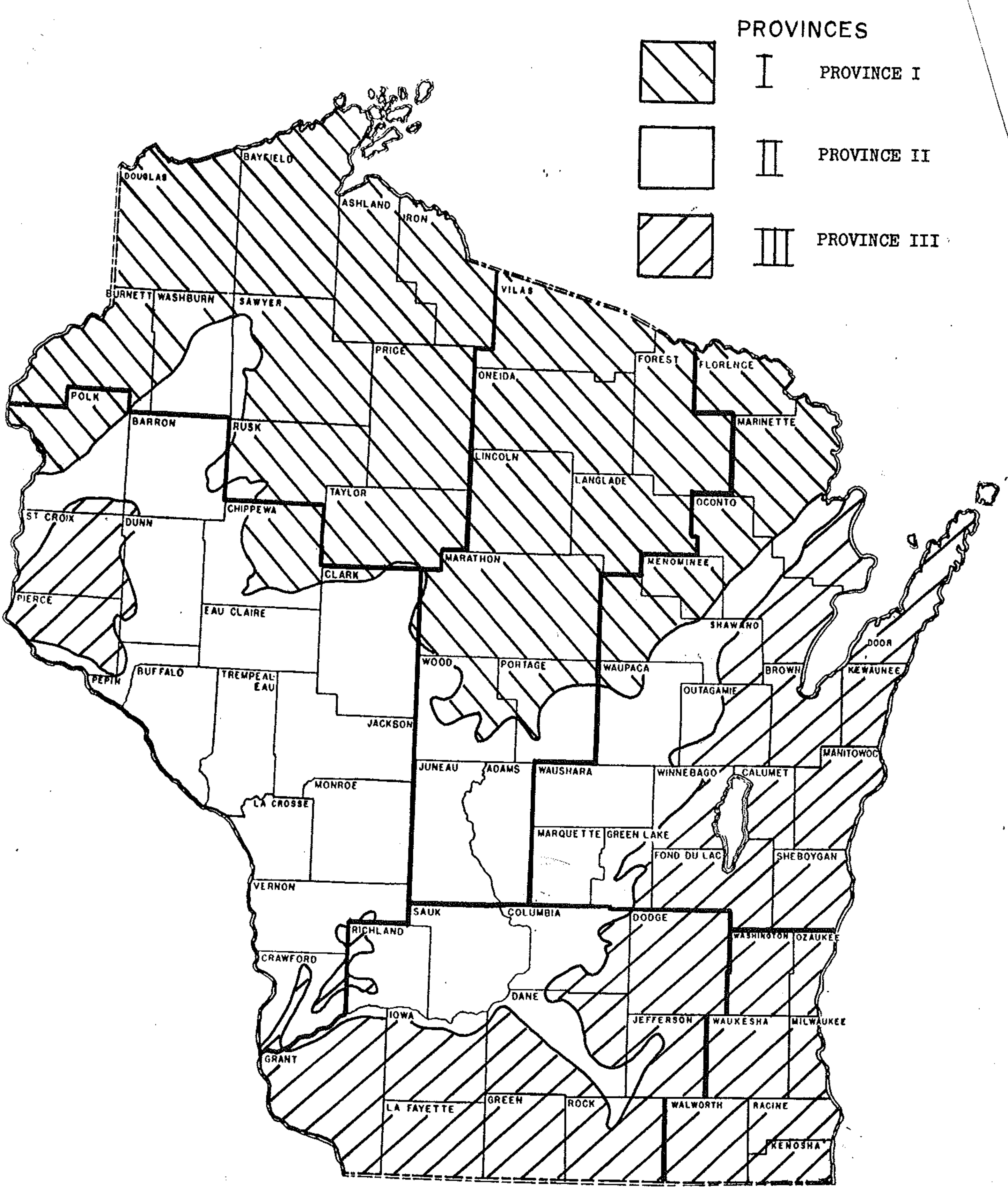
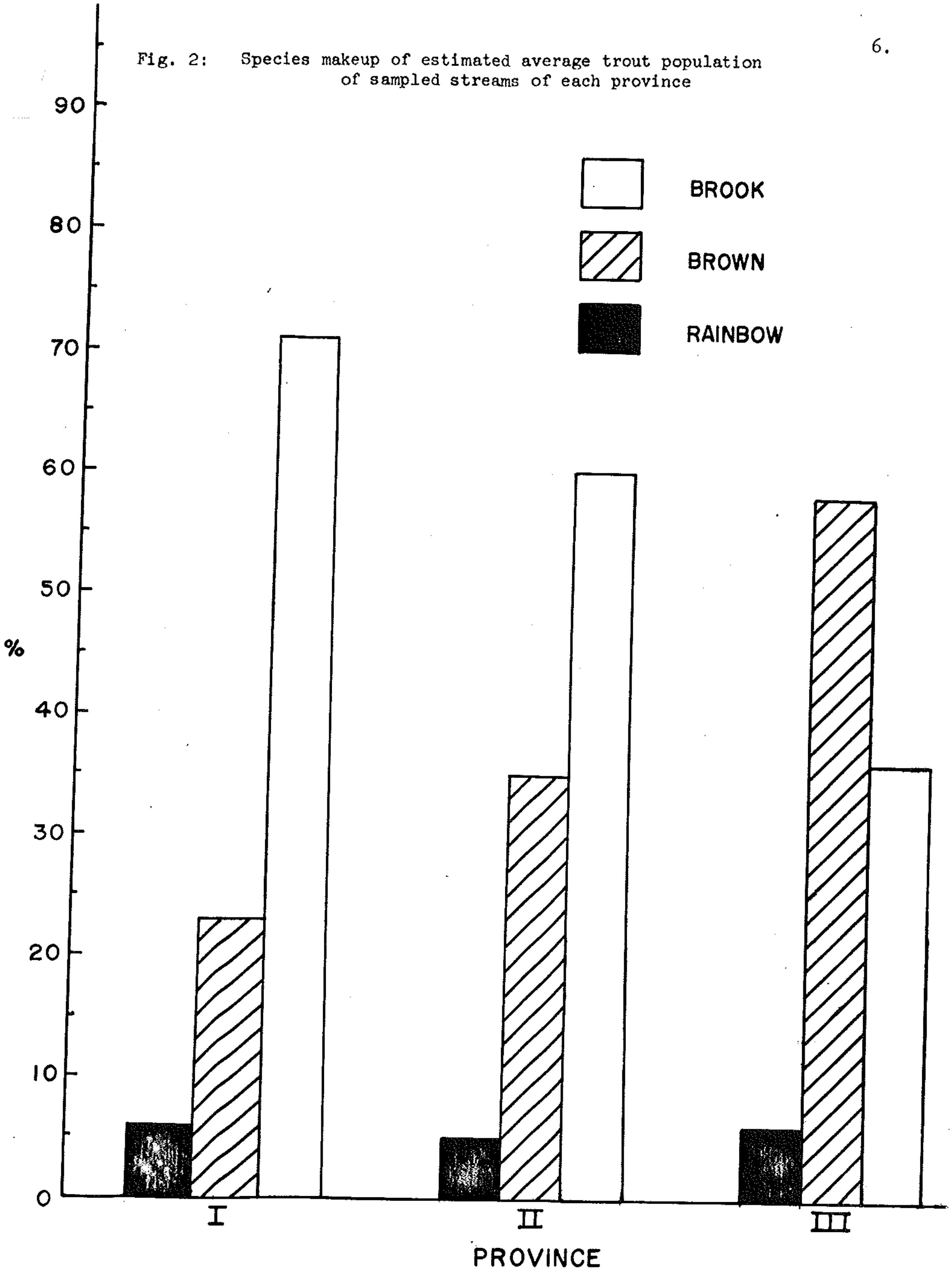


Fig. 1: Valid hydro-chemical lake regions with respect to total alkalinity, based on bedrock provinces. (Poff, 1970)

Fig. 2: Species makeup of estimated average trout population of sampled streams of each province



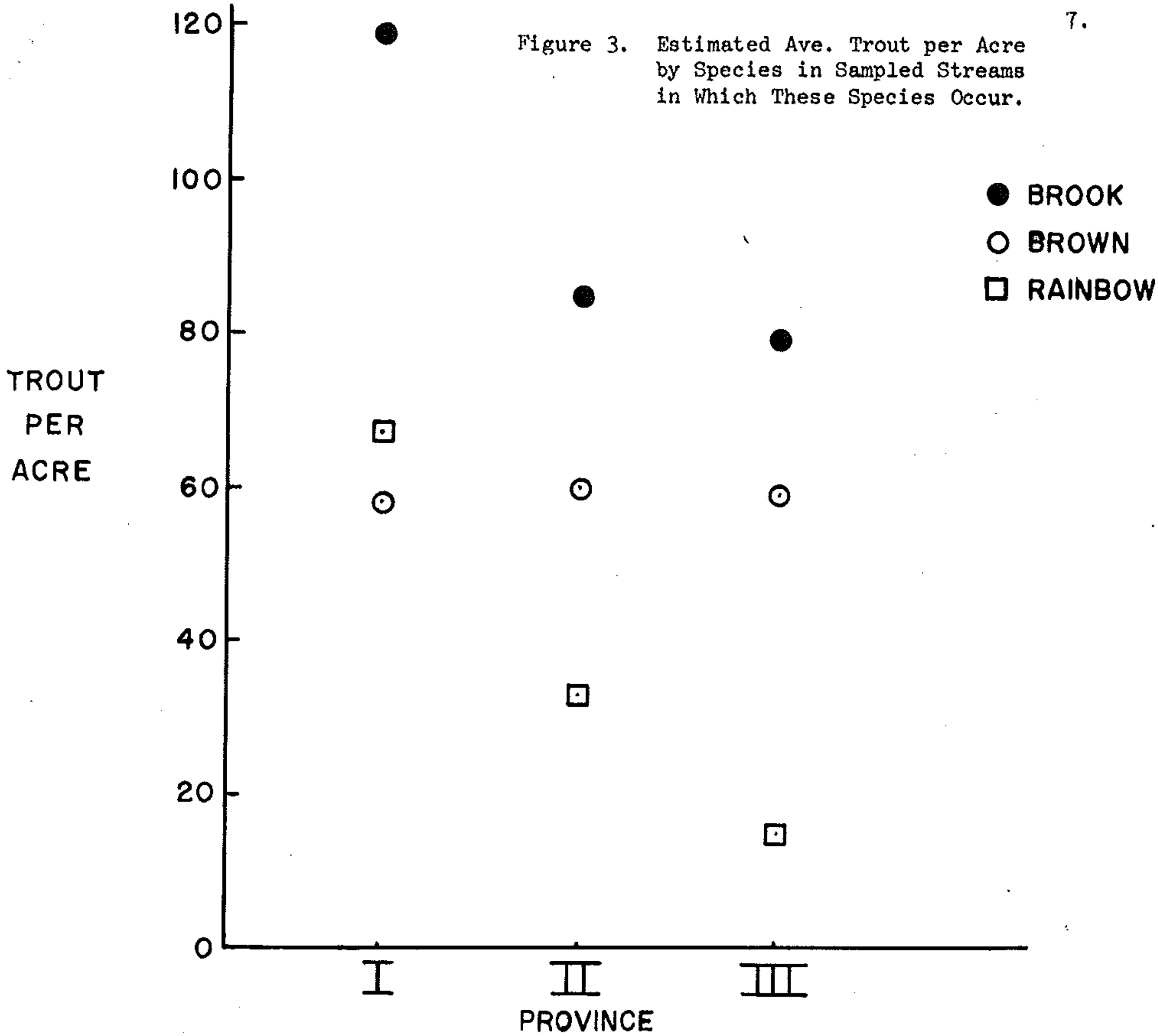


Figure 3. Estimated Ave. Trout per Acre by Species in Sampled Streams in Which These Species Occur.

Percent of sampled streams in which each species occurs.

	PROVINCE I	PROVINCE II	PROVINCE III
BROOK	97	86	41
BROWN	63	74	86
RAINBOW	11	16	36

Figure 4. Trout densities on sampled streams of each province, showing mean, range, and one standard deviation on each side of the mean.